REMARKS

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

Page 3, line 6 of the specification has been amended to correct a typographical error in the temperature range. Specifically, "110°C" has been corrected to --1100°C--. Support for this change can be found on page 9, line 22 of the specification. Further, 110°C is clearly a typographical error because this temperature is far too low for a forging operation, and does not make sense with a cooling down to 600°C-300°C, as required by the subsequent process step recited in the claim.

Claim 1 has been amended to correct the same typographical error discussed above, and to replace "forged air" with --forced air--. Support for the latter change can be found on page 3, line 8, page 4, line 31, and page 6, line 7 of the specification. Additionally, claims 1, 11 and 12 have been amended to make minor editorial changes. Claim 4 has been amended to recite "where the Ti content is equal to at least 3.5 times the N content of the steel." Support for this amendment can be found on page 3, lines 20 and 21 of the specification.

New claim 18 has been added to the application, reciting the limitations of claims 1-5.

The patentability of the present invention over the disclosures of the references relied upon by the Examiner in rejecting the claims will be apparent upon consideration of the following remarks.

Thus, the rejection of claims 1, 6 and 15-17 under 35 U.S.C. § 102(b) as being anticipated by Burnett et al. is respectfully traversed.

Burnett et al. do not teach or suggest a method of fabricating a steel part by preparing and casting a steel with Applicants' recited composition, forging a blank, and cooling the blank in still or forced air at a speed less than or equal to 3°C/s in the range of 600°C to 300°C, thereby imparting a bainite microstructure to the blank, as required by Applicants' claim 1. Specifically, Applicants' claimed method results in a bainitic microstructure on the crankshaft. Burnett et al. disclose that bainite is present in the fillet region of the described crankshafts, but there is also a significant presence of undissolved ferrite. (See column 5, lines 41-43 of the Burnett et al. reference.) This particular portion of the reference does not specifically discuss the nature of the main part of the microstructure. However, Burnett et al. further describe other trials which aim at producing bars having the same microstructure of an "as-forged crankshaft crankpin section ".

(See column 6, lines 32-33 of the reference.) Additionally, Burnett et al. describe this microstructure, stating that it is identical to what was observed on the crankshafts. Specifically, the microstructure in the core of the samples is ferrito-pearlitic and bainite can only be found in the upper layer (the case) and in combination with undissolved ferrite and martensite. Burnett et al. do not teach or suggest the case of Applicants' invention, but rather describe a case which is close to the prior art, which is discussed in the examples of Applicants' specification.

Ordinary ferrito-pearlitic steels are subject to greater softening than the steels of the invention, which on the contrary, have a tendency to become stronger while in use. Additionally, for lower burnishing loads, Applicants achieve the same results in terms of mechanical properties as with conventional ferrito-pearlitic grades. Therefore, it is possible to economize on burnishing wheels, and reduce the cost of the burnishing operation. This compensates for the extra cost due to the greater presence of alloying elements in the steel. Additionally, the steel produced according to Applicants' claimed method has a tensile strength of about 1000 MPa or higher, due to the bainitic structure of the core. On the contrary, the ferrito-pearlitic core structure of Burnett et al. allows tensile strengths of only about 800 MPa.

The Examiner states that the teaching in Burnett et al. to cool to room temperature would be equivalent to less than 3°C/sec, since Applicants also air cool. However, Burnett et al. do not teach that the cooling should be in a controlled manner in still or forced air at a speed less than or equal to 3°C/s in the range 600°C to 300°C in order to obtain a bainite microstructure, as required by Applicants' claim 1. The fact that Burnett et al. do not obtain this type of microstructure demonstrates that the cooling speed requirement of Applicants' claims is not taught or suggested by the reference. Furthermore, the difference in microstructure demonstrates that the recited cooling speed and temperature are important elements of Applicants' claimed method.

Another fundamental distinction between the teachings of Burnett et al. and Applicants' claimed invention is that Burnett et al. reinforce the crankpins of the crankshaft by an induction heating, followed by a quench. On the contrary, in Applicants' claimed invention, the reinforcement is performed mechanically (claim 1), in particular by burnishing (claim 14). When the crankshaft crankpins are reinforced by burnishing, as in Applicants' claim 14, and not by induction quenching, the bainitic structure of the invention is better than the ferrito-pearlitic structure of Burnett et al., as evidenced by the examples set forth in Applicants' specification.

The examples according to Applicants' claimed invention have better resistance to fatigue and better residual compression stresses.

Burnett et al. seek a structural change of the near-surface part (case) of the crankpin, which gives it a mostly martensitic structure. This is obtained by a localized induction heating, followed by a quench, and optimally a tempering which reduces the compressive residual stress level. This reheating must take place at a low temperature (up to 350°C, but generally far lower) in order to not disturb the mechanical properties of the core.

In Applicants' invention, the mechanical reinforcement, or burnishing, has very different structural effects. The purpose of Applicants' invention is not to form a martensitic structure, but rather, to form a favorable pattern of residual stresses within the bainitic structure. In some instances, Applicants' invention does include a slight annealing at 300-500°C. (See page 11, lines 26-33 of Applicants' specification). However, the annealing step disclosed in Applicants' specification differs greatly from the tempering step of Burnett et al. Specifically, Applicants' annealing step can be performed at a far higher temperature than the tempering step of Burnett et al; Applicants' annealing step affects the whole part, not only a surface of the crankshaft crankpins; and Applicants' annealing can be performed after the cooling and after or before machining, but always before the mechanical reinforcement or burnishing. The tempering of Burnett et al. is performed after the heating/quench operation. If the annealing of Applicants' invention was performed after the burnishing, in order to make it like the teachings of Burnett et al., it would destroy the effects of the burnishing. Therefore, the tempering step of the reference teaches away from Applicants' recited invention.

Further, the bainitic structure of Applicants' invention is particularly advantageous when a burnishing is performed on it. The reference example in Applicants' specification, which has an ordinary ferrito-pearlitic structure, has mechanical properties after burnishing which are greatly inferior to the properties of the examples according to Applicants' invention.

Additionally, a mechanical reinforcement of the crankpins, such as by burnishing, has the following advantages over an induction heating/quench reinforcement. It is easily limited to the very area to be reinforced, while an induction heating/quench treatment can have affects in neighboring areas. In an induction heating/quench treatment, there is a risk of causing deformations of the part during the quench, which can be overcome only if a tempering is performed afterwards. A mechanical reinforcement does not cause such deformations, and

consequently it may be performed after the final machining of the part without impairing the precision of its dimensions and without necessitating further treatments.

Mechanical reinforcement, such as by burnishing, as recited in Applicants' claims, results in optimized mechanical characteristics. (See page 5, line 34- page 6, line 1 of Applicants' specification.)

For these reasons, the invention of claims 1, 6 and 15-17 is clearly patentable over Burnett et al.

The rejection of claims 2-5 and 7-9 under 35 U.S.C. § 103(a) as being unpatentable over Burnett et al. in view of Hase et al. or Watari et al. is respectfully traversed.

The Examiner takes the position that since hardness and machinability are desired and sought by Burnett et al., then it would be an obvious modification well within the skill of the artisan in view of the secondary teachings to add small amounts of B, Ti, Nb, or at least one of Ca, Te, Se, Bi and Pb to produce no more than the known and expected effect of such an addition.

However, as discussed above, Burnett et al. do not teach or suggest the limitations of Applicants' claims. Furthermore, neither Hase et al. nor Watari et al. remedy the deficiencies of the Burnett et al. reference. In particular, neither reference teaches or suggests performing a mechanical reinforcing operation, as required in Applicants' claims.

Therefore, the combination of references relied upon by the Examiner do not teach or suggest Applicants' claimed method, and the invention of claims 2-5 and 7-9 is clearly patentable over Burnett et al. in view of Hase et al. or Watari et al.

The rejection of claim 14 under 35 U.S.C. § 103(a) as being unpatentable over Burnett et al. in view of Heffron et al. is respectfully traversed.

The Examiner takes the position that Burnett et al. disclose a method of fabricating a steel part which performs a mechanical reinforcing operation with induction hardening rather than burnishing. However, the Examiner is incorrect that the induction heating/ quenching of Burnett et al. is a mechanical reinforcing. A mechanical reinforcing implies a contact between a tool and the part to be reinforced. This does not occur in an induction heating/ quench operation.

The Heffron et al. reference refers to a burnishing of the bearing surfaces of a crankshaft. The term "burnished" has a different meaning in the Heffron et al. reference than in Applicants' claimed process. Specifically, "burnished", as discussed by Heffron et al., does not refer to a

mechanical reinforcing operation, but rather a machining operation which aims at making the bearing surface as smooth as possible. On the contrary, Applicants' use of the word "burnishing" refers to a mechanical reinforcing performed with rolls which cause high compressive mechanical residual stresses and a surface hardening. (See page 1, lines 18-35 and page 5, line 13-14 of Applicants' specification.)

The discussion in Heffron et al. focuses on the precise positioning of the crankshaft, which is of fundamental importance during a machining operation. (See column 1, lines 9-11 of the reference.) In this context, it is clear that "burnishing" means "precisely machined". Additionally, the parts of the crankshaft which are treated in the Heffron reference are the bearing surfaces, rather than the locations that are to be subjected to particularly high levels of stress, i.e., the fillets connecting the crankpins (which are the parts reinforced by Applicants' invention.)

Therefore, the Heffron et al. reference does not remedy the deficiencies of the Burnett et al. reference, and the invention of claim 14 is clearly patentably over Heffron et al. in view of Burnett et al.

The rejection of claims 1-15 under 35 U.S.C. § 103(a) as being unpatentable over Bellus et al. in view of Heffron et al. is respectfully traversed.

The Examiner admits that Bellus et al. do not teach mechanical reinforcing operation. The Examiner takes the position that mechanical reinforcement would be an obvious step well within the skill of the artisan to incorporate since it is a standard conventional step well known in the art when producing crankshafts for automobiles. The Examiner also points to Heffron et al. as teaching machining and burnishing.

However, as discussed above, the term "burnished" has a different meaning in the Heffron et al. reference than in Applicants' claimed process. Specifically, "burnished", as discussed by Heffron et al. does not refer to a mechanical reinforcing operation, but rather a machining operation which aims at making the bearing surface as smooth as possible. On the contrary, Applicants' use of the word "burnishing" refers to a mechanical reinforcing performed with rolls which cause high compressive mechanical residual stresses and a surface hardening. (See page 1, lines 18-35 and page 5, line 13-14 of Applicants' specification.)

Therefore, the teachings of Heffron et al. do not remedy the deficiencies of Bellus et al., specifically the lack of a mechanical reinforcing operation.

Additionally, regarding the Examiner's assertion that a mechanical reinforcement operation is a standard conventional step within the art, the Examiner has provided no evidence to support this assertion. As admitted by the Examiner, the Bellus reference does not teach a mechanical reinforcement operation, as required in Applicants' claim 1. Further, as discussed above, the Heffron et al. reference does not teach a mechanical reinforcement operation. In the absence of evidence that a mechanical reinforcement operation would be obvious, or motivation to add this step to the process of Bellus, Applicants respectfully submit that this rejection is based on hindsight, which is improper according to U.S. practice. Therefore, this rejection should be withdrawn. In re Zurko. 59 USPQ2d 1693.

For these reasons, the invention of claims 1-15 is clearly patentable over Bellus et al. in view of Heffron et al.

Additionally, new claim 18 is further patentable over the cited references, and combinations thereof, because none of the references teach or suggest a method of fabricating a steel part by forging, comprising preparing and casting a steel, wherein the steel contains 0.005% to 0.06% Nb, 0.005% to 0.04% Ti, where the Ti content is equal to at least 3.5 times the N content of the steel, and 5 ppm to 50 ppm of B, as recited in new claim 18.

Therefore, in view of the foregoing amendments and remarks, it is submitted that each of the grounds of rejection set forth by the Examiner has been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

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